mainly because: a) the 1940 United States population was much younger than more recent North Carolina and U.S. populations, and b) death rates are much higher in the older age groups. Therefore, standardizing to a much younger population results in a much lower age-adjusted death rate. In recognition of this problem, the National Center for Health Statistics and the State Center for Health Statistics now use the year 2000 United States population as the standard population (reference #2). This means that the age-adjusted death rates are generally much more similar in size to contemporary crude death rates.

One should be especially careful when assessing trends over time using age-adjusted death rates. **It is essential that rates for different years be adjusted to the same standard population before making comparisons.** Also, if the standard population is very different from the populations of the years being compared (as is often the case when using the 1940 U.S. standard), changes in the adjusted rates over time may not be an accurate reflection of the actual changes in the risk of death. In an attempt to promote comparability of age-adjusted death rates over time, the State Center for Health Statistics recomputed age-adjusted death rates for the period 1979 through 1998 (years in which the 9th revision of the International Classification of Diseases was used for death coding) using the 2000 U.S. standard population. This time series of rates can be accessed at www.schs.state.nc.us/SCHS/deaths/lcd/1998. All adjusted death rates in State Center for Health Statistics publications for the years 1999 and forward use the 2000 U.S. standard population for age adjustment, though for some causes of death there are problems of comparability with previous years due to the use of the 10th revision of the International Classification of Diseases for death coding beginning in 1999.

Errors of Adjusted Rates

A detailed discussion of random errors in age-adjusted death rates is beyond the scope of this paper. The reader should refer to the *Statistical Primer* cited in reference #1 for information on the general concepts of random errors in rates, confidence intervals, and determining if the difference between two rates is statistically significant. Using the terminology in that paper, a 95% confidence interval around a proportion can be computed.

✎ *Formula:*

95% confidence interval around a proportion =

$$p \pm 1.96 \sqrt{\frac{pq}{n}}$$

The $\sqrt{pq/n}$ is commonly known as the **standard error of the proportion.** In this case a death rate is treated as the proportion (p) of people who died during the time period of interest. If the proportion who died is small, then q (which is 1-p or the proportion who did not die) will be very close to 1.0 and the formula becomes $\sqrt{p/n}$, where n is the total population.

We saw from the discussion above that a directly age-adjusted death rate is a weighted sum of the age-specific death rates. To get the standard error of the age adjusted death rate, sum up all the products of the square of the weight (w) for each age group and the standard error (squared) of the age-specific death rate. Then take the square root of the sum.

✎ *Formula:*

Standard error of the age-adjusted death rate =

$$\sqrt{\sum_{i=1}^{10} w_i^2 \, (p_i/n_i)}$$

Remember that the weight is simply the proportion of the standard population in age group i. To get the 95% confidence interval around the age-adjusted death rate, multiple the standard error of the age-adjusted death rate by 1.96.

This is a very brief discussion of a lengthy topic. For questions or assistance, please contact the author.

Issues in Adjusting for Race and Gender

For many years, the death rates in the *Leading Causes of Death* publication of the State Center for Health Statistics were adjusted simultaneously for age, race, and gender. This was done for five-year death rates for specific causes of death, by county of residence. With 40 age-race-gender-specific rates being computed (10 age groups x 2 race groups: white/minority x 2 gender groups), the data were being spread too thin. A particular problem was in the western North Carolina counties, which generally have very small minority